

Calotropis Procera Assisted Green Synthesis of Zinc Oxide Nanoparticles

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ABSTRACT: Herein, a microwave assisted, inexpensive green route has been demonstrated for the synthesis of ZnO nanoparticles by using milky latex of *calotropis procera* (madder) which act as reducing agent. The synthesized nanoparticles were characterized by different techniques such Fourier transform infrared spectroscopy (FT-IR), UV-visible spectroscopy and X-ray diffraction. (XRD) The FTIR spectra reveal that the presence of hydroxyl group, aldehyde, ketone and carboxylic group which are responsible for biochemical reaction. The XRD pattern indexed that ZnO nanoparticle hexagonal wurtzite structure with particle size ranging from 17-19 nm. The UV-visible absorption spectra shows an absorption peak at 292 nm and energy band gap is found to be 4.24 eV. The ZnO nanoparticle exhibits an excellent photo catalytic performance for the degradation of methylene blue dye in aqueous solution under the UV irradiation

KEYWORDS: Microwave synthesis. ZnO nanoparticle. Calatropis Procera.

I. INTRODUCTION

Nanosized ZnO NPs has been prepared by using physical and chemical method. The conventional methods were utilized for the creations of nanoparticles are very costly and toxic to the environment due to association of various hazardous chemicals. [1] Due to the adverse impact on the environment of conventional techniques for the preparation of nanomaterials, there is an urgent need to replace such methods by green synthesis methods. A biological method for the synthesis of metal and metal oxide NPs is one of the promising and environmental benign methods.[2] Many methods are used to synthesise ZnO Nps, few of them are coprecipitation method [6], hydrothermal method [7],sol-gel method [8], electro deposition [9] and green synthesis. [10]

Green Synthesis of the ZnO NPs utilizes the extracts of different plants, including *Acalypha indica*, *Aloe vera*, *Calotropis gigantea*, *C. procera*, *Ixora coccinia* and *Catharanthus roseus*,. [3-5] Biological method has several advantages such as consumption of very less time, low-cost precursors, high purity product and does not require any costly equipment over the chemical methods.

Further, among metal oxide NPs, zinc oxide nanoparticles have potential applications in various areas such as coatings for the solar cells, optical, piezoelectric, magnetic and gas sensing and also exhibit high catalytic efficiency, strong adsorption ability, high isoelectric point (9.5), biocompatibility, and fast electron transfer kinetics for biosensing purposes [11-15].

Calotropis procera, is a well known desert plant called a Madar in Greco Arab medicine. This plant is evenly distributed in tropical and subtropical Africa and Asia. The different parts of the plant are used in Indian traditional medicine for the treatment of painful muscular spasm, dysentery, fever, rheumatism, asthma and as an expectorant and purgative. [16] Usually, the extract of *C. procera* is used topically for the treatment of ringworm [17]. *C. procera* is a plant with good enough amounts of latex, consisting of several biologically active compounds, including proteins, amino acids, carbohydrates, lipids, vitamins, alkaloids etc.

In present work, ZnO NPs are synthesized through a microwave assisted green route using milky latex of *Calotropis procera* (C.P.) Biogenic synthesis method is greener, simple and eco-friendly. The ZnO Nps were characterized by using XRD, FT-IR and UV-Vis Spectroscopy. ZnO Nanoparticle was studied for the photocatalytic degradation of methylene blue (MB) dye.

II. EXPERIMENTAL

The zinc nitrate, sodium hydroxide was purchased from S.D. fine chemical ltd. Mumbai, India. All the chemicals were of analytical reagent grade and used without further purification. The ZnO nanoparticle was prepared by microwave assisted route. [18-19] 0.01 M aqueous solution of zinc nitrate was added in 50 ml distilled water under vigorous

stirring. Milky latex of madder 5 ml was added to above solution. After addition of milky latex, 1.0 M NaOH solution was added into above solution. The solution mixture was kept on hot plate of micro oven (RAGA'S Microwave system, 700 W) for period of 5 min at 60° for complete bio reduction of Zn(NO₃)₂. The resulting white solution was placed on magnetic stirrer for 2 hrs. The white precipitate was obtained and washed several times with distilled water followed by ethanol to remove impurities. The dry white powder was calcinated at 400° in muffle furnace for 2 hrs.

III. RESULTS AND DISCUSSION

X-ray Diffraction Method (XRD)

The powder x-ray diffraction methods are used to study the structural properties and the phase purity of the samples. Fig.1 shows the XRD spectra of the synthesized ZnO nanoparticle which are annealed at 400°C. The intense diffraction peaks of ZnO appears at 16.5, 23.63, 26.6, 29.57, 35.51, 38.55, 41.65, and 46.27° which correspond to (100), (002), (101), (102), (110), (103), (200), (112) respectively. All the diffraction peaks, which have been labeled with (hkl) planes were matches with JCPDS card no.(36-1451). The detected peaks are certainly indexed as ZnO hexagonal wurtzite structure verified by PDF Code: 36-1451. The (101) peaks shows variation in the intensity at 26.60° Bragg's angle. The Particle size of nanoparticle was determined using the Debye Scherrer equation.

$$D = K \lambda / \beta \cos\theta$$

Where K is constant equal to 0.94, D and λ are the particle size in nanometer and wavelength of the radiation (1.54056 Å for Cu K α radiation), respectively. β and θ are the peak width at half-maximum intensity (FWHM) and peak position. The average crystallite size of ZnO is found to be 17-19 nm.

UV-Visible Spectroscopy

The UV spectra of Co doped ZnO are examined using (Shimadzu- 1800) UV-Visible Spectrophotometer in the visible range. Fig.2 represents the absorption spectra of ZnO nanoparticle at 292.0 nm in the visible range between 200 - 800 nm of wavelength, which indicate the formation of ZnO nanoparticle by green synthetic route. The band gap energy is calculated on the basis of maximum absorption band of ZnO. From the UV-Visible spectra, it was found that absorption band at 292.0 nm for ZnO nanomaterial.

The band gap energy is calculated according to following equation.[20]

$$E_{bg} = \frac{1240}{\lambda}$$

Where E_{bg} is the band gap energy and λ_{max} is the wavelength (292.0 nm) of the nanomaterial. The energy band gap (E_{bg}) for ZnO was found to be 4.24 eV.

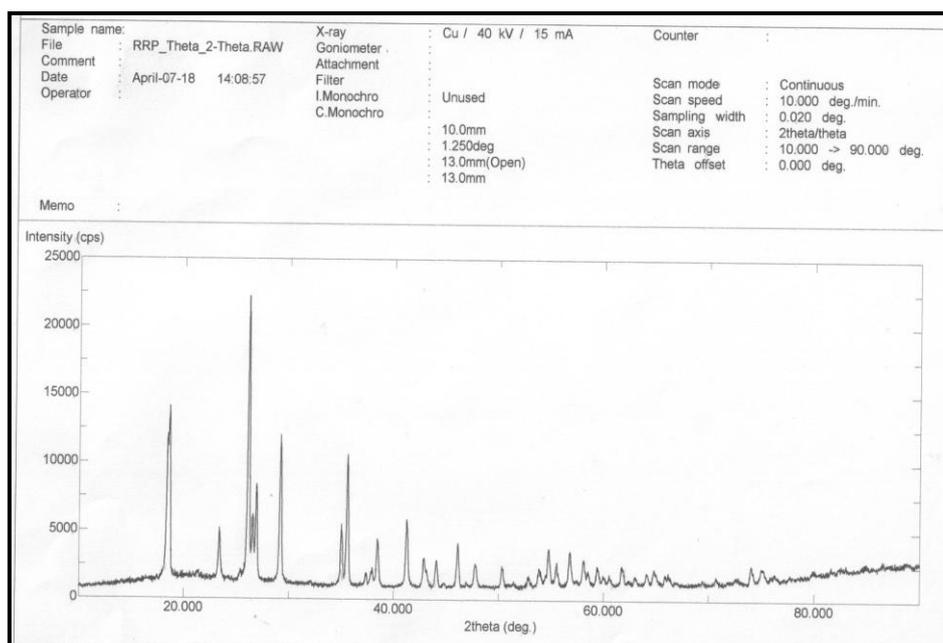


Fig. 1 XRD Pattern of ZnO nanoparticle

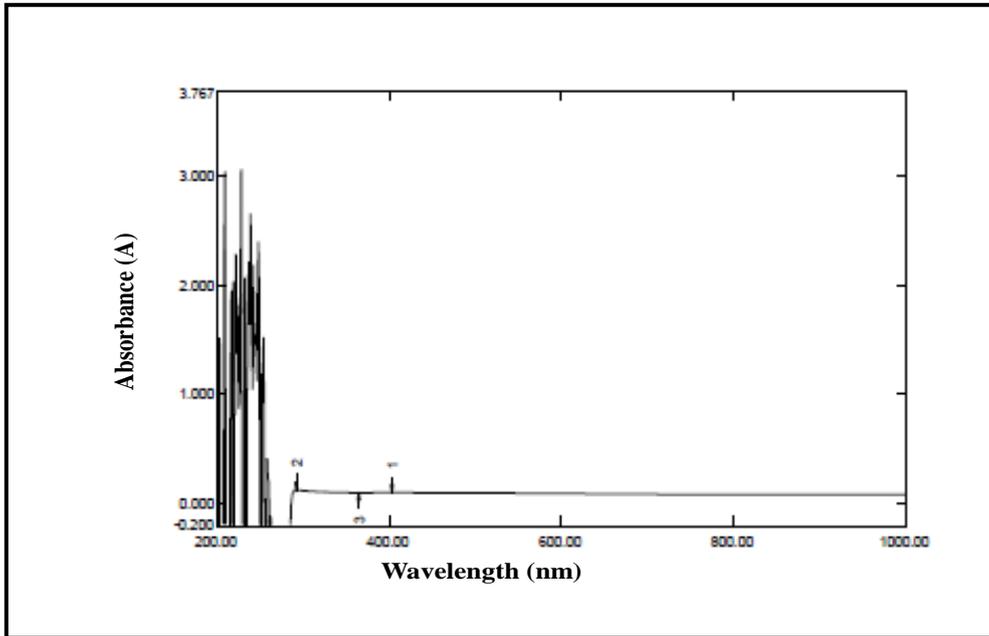


Fig. 2. UV-Visible spectra of ZnO nanoparticle

FTIR Spectroscopy

In view of confirming the composition, purity, the nature of the functional groups on the surfaces of ZnO nanoparticle, Fourier Transform Infrared (FTIR) spectroscopy was used. Fig. 3 gives FTIR spectra of ZnO nanoparticle by using green synthetic route. The FTIR spectrum of Zinc oxide nanoparticles showed an absorption peak exhibited in lower wave numbers (416.64, 551, 601 and 621.11 cm^{-1}). In general, metal oxides are characterized by intrinsic absorption bands below 1000 cm^{-1} (the so called fingerprint region) arising from inter-atomic vibrations which is associated to the stretching mode of Zn-O and in higher wave numbers (3217 cm^{-1}) which can be assigned to O-H group. This is related to the absorbed water on the surface of nanomaterial.

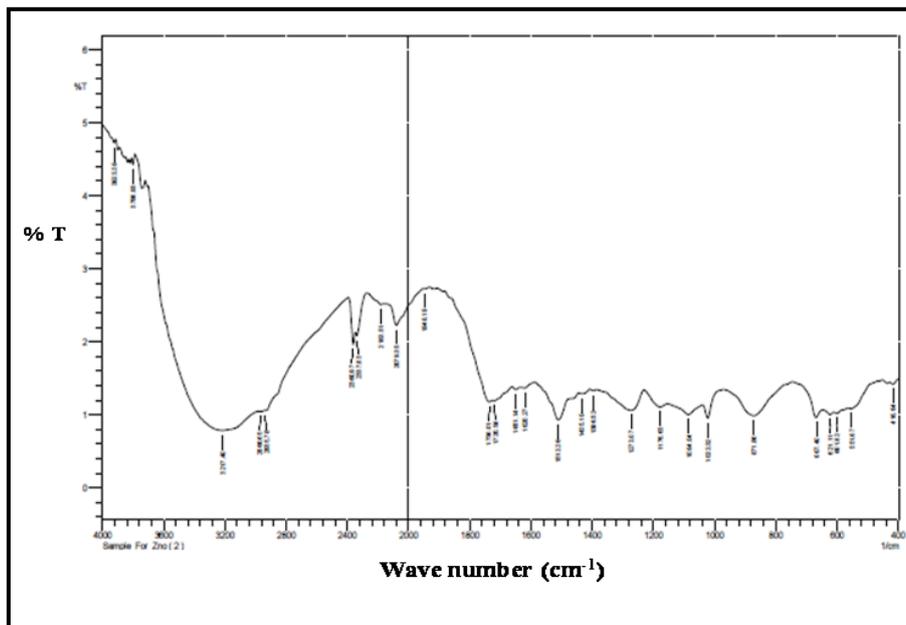


Fig. 3 FTIR spectra ZnO nanoparticle

IV. CONCLUSION

In summary, a green novel route for the rapid, eco-friendly and non-toxic synthesis of ZnO NPs using milky latex of *Calotropis Procera* has been developed first time. The XRD pattern confirmed hexagonal wurtzite structure of ZnO. The average particles size has been determined by using Debye Scherrer equation was found to be 17-19 nm. From UV- Visible spectroscopy, it reveals that observed band gap energy was found to be 4.24 eV. FTIR shows that peak at 416.64, 551.87 cm^{-1} is the characteristic absorption of zinc oxide (Zn - O) bond which confirms formation of zinc oxide nanoparticle.

Zinc oxide nanoparticles synthesized from above mentioned route are expected to have more extensive application in biotechnology, sensors, medical, catalysis, and water remediation.

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